MINOR STUDIES FROM THE PSYCHOLOGICAL LABORATORY OF CORNELL UNIVERSITY.

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XII.—A STUDY OF CERTAIN METHODS OF DISTRACTING THE ATTENTION.

I.—ADDITION AND COGNATE EXERCISES: DISCRIMINATION OF ODORS.

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INTRODUCTION.

The experiments to be described in this paper were performed at the Cornell University during the academic year 1895-96. The ultimate purpose of the whole investigation, of which this is the first part, is to discover a reliable *measure of the attention* by means of some form of distraction which shall possess at least the qualities of (1) capability of gradation, (2) continuity and (3) possibility of general use with normal subjects. The present writer has tried only to accomplish the following: first, to examine the most commonly used form of mental distraction, addition, in order to find out if it affects all persons in the same way, and can therefore be considered a measure of the attention; and, secondly, if addition cannot be so considered, to examine other forms of mental distraction with the object of finding one which gives promise of possibility of use as such a measure.

The problem is an important one in every investigation into which attention and inattention enter. If the form of distraction used does not affect all the subjects equally, evidently the investigator will be dealing with varying degrees of attention, and, indeed, may not reach the state of inattention in any one of his subjects. To assume under such circum-

stances that all are completely and thoroughly distracted precludes, of course, results of any great value.

Several writers have recognized the inadequacy of our present methods of measuring attention. Thus Professor Külpe[1] remarks: "It is clear . . . . . . that the mere employment of distracting stimuli of a certain intensity or number is absolutely no guarantee that a corresponding distraction of the attention has actually been accomplished. The discovery of a reliable measure of the attention would appear to be one of the most important problems that await solution by the experimental psychology of the future." Professor Stanley in an article in the *Psychological Review*[2] for January, 1895, raises the question: "What is 'full' attention? Is it a scientifically determinable state, and one which can be induced as readily as securing air full of moisture at what we term saturation point? How can the experimenter be sure of attention at a certain degree? The inexactness of experimental psychics as compared with physics is certainly great. The intensity of cognitive effort is neither easily discernible nor measurable." As yet, however, there has been published, so far as we know, no experimental investigation of the actual workings of a distraction. The present study, although brief and very incomplete, will, it is hoped, at least call attention to this problem as a fruitful one for exact experimental inquiry.[3]

SECTION I.—ADDITION AS A DISTRACTION.

The work for which addition was given as a distraction consisted in the discrimination of various shades of gray, procured by revolving black disks with white sectors. The amount of white in the disks varied from 65° to 115°. The experiments were given in a series of ten each, with differences of 10° and 15° in one series, 10° in another, and 5° and 10° in the third. The subject was allowed to look at each disk for three seconds, the interval between the showing of the disks being six seconds. No attempt was made to keep the interval between the experiments more than roughly constant.

The discrimination was made under varying conditions of

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[1] "Outlines of Psychology," 1895, p. 429.

[2] Vol. II, p. 53.

[3] Other papers dealing more or less directly with this problem of distraction of the attention are: Swift, E. J., "Disturbance of the Attention during Simple Mental Processes," AM. JOURNAL OF PSYCHOLOGY, Vol. I, p. 1. Smith, W. G., "The Relation of the Attention to Memory," Mind, N. S., Vol. IV, p. 47. Bertels, O., *Die Ablenkung der Aufmerksamkeit*, Dorpat, 1888.

distraction. Approximately 300 experiments were performed with each of three subjects.[1] In 100 of these no distraction was given, in 50 there was distraction while the first disk was being shown, and in another 50 distraction while the second disk was being shown. With the other 100 experiments the distraction began before the first disk was displayed, and continued until the second had been shown. In every case the subjects were requested to give as much attention as possible to the addition problems, which were read to them by the experimenter.

The results are shown in Table I, the figures representing percentages of correct judgments.

TABLE I.

SUBJECT.	NO DISTRACTION.	DISTRACTION. SHOWN 1st.	DISTRACTION. SHOWN 2d.	DISTRACTION DURING WHOLE EXPERIMENT.
P.	75	73	75	59.5
		Average 74		
H.	84	82.5	74	77
		Average 78.25		
R.	74	81.5	86	85
		Average 83.75		

An examination of this Table shows that of the three subjects *P.* alone gives very nearly the results we might expect if we assume that addition is a continuous distraction, producing practically a state of inattention. And yet his average of correct judgments is as high when he was distracted while the second disk was being shown as when there was no distraction at all. The results of *H.*, if the average of the second and third columns be taken, show a slight tendency downward from the experiments with attention to those with 'inattention,' but the difference is much less than might be expected. Moreover, *H.* shows a higher percentage of correct judgments with distraction during the whole experiment than with distraction only while the second disk was being shown. *R.*'s results are the most surprising of all. If the average of the

[1] Miss H. I. Root (*R.*), Miss A. J. Hamlin (*H.*), Dr. W. B. Pillsbury (*P.*). [For the general plan of these experiments, see Miss Hamlin's paper on "Addition and Distraction," AMERICAN JOURNAL OF PSYCHOLOGY, VIII, pp. 47, 53 ff. It may be mentioned here that the subjects in Miss Hamlin's investigation were Professor Hammond (*H.*, wrongly given as *A.* on p. 48); Mr. Moyer (*M.*); Dr. Pillsbury (*P.*); Miss Root (*R.*); Mr. McVannel (*V.*); Professor Margaret Washburn (*W.*). Mr. Moyer's subjects had, therefore, all had experience in work similar to his; and their results, though comparatively few in number, may be relied upon.]

second and third columns in her results be taken, as with *H.*, the three numbers,—74, 83$\frac{3}{4}$, 85,—show that the judgment improves with increase of the amount of distraction. These results clearly show, first, that addition as a distraction affects different people differently ; and secondly, that it cannot be depended upon to produce uniform results, even with the same subject. These conclusions are also borne out by the notes taken while the investigation was in progress. As these notes explain, to a considerable extent, the numerical results given in the Table, some of the more important of them, particularly those which describe the actual effect of the distraction on the mental processes of the subject, are given here.

Especial care was taken to secure from the subjects as full a description as possible of the mental processes involved in the addition. (1) *P.*'s method of adding was somewhat peculiar. The addition as a whole seemed to be visual, but the actual process of adding was tactual-verbal. *P.* first visualized the numbers on a black background, the numbers themselves being white. They were not projected to any part of the room during the process ; but sometimes the subject had a vague, indefinite idea of the inside of his skull as a background, which at such times appeared black, and not red, as he usually thinks of it. As soon as the numbers have been visualized clearly, their visual images fade away and the actual process of adding begins. In adding 236 and 189, for instance, *P.* begins with the hundreds column. Without really adding the tens column, he "knows" that there is one to carry and says "4." Then he "thinks about the rest." The addition for a moment becomes indefinite and is partly automatic. The mind seems to relax between the first and second parts of the work. It is during these intervals between the partial results of the addition that the image of the disk, which had dropped out of consciousness when the numbers were first visualized, again comes in. But it immediately disappears as soon as the subject 'gets down to business' again, just before announcing the full result.—This description, although taken from the notes of an addition performed while the first disk was being shown, applies equally well to the other two cases. In adding during the whole experiment, when a number is given him to add to his first result, *P.* keeps the first result in mind, but usually thinks of the disk at the same time, and gathers up the fragments of its memory image as much as he can. The two processes conflict, however, and in addition during the whole experiment, the memory image of the first disk is, according to the subject's own account, very vague. This is borne out by the sudden falling off in the Table of his percentage of correct judgments

in distraction during the whole experiment. When the addition is given only while the first disk is being shown, he has plenty of opportunity to gather up the fragments of the image caught in the intervals of the addition, and so gets a fairly definite idea of it. The slightly higher percentage with distraction while the second is being shown bears out his statement that he did not pay as much attention to the addition in that case, because he was more interested in the disk, having had an uninterrupted view of the one first shown.

(2) *H.*'s method of adding can be best described by giving her own account of an actual case. The numbers given were 147 and 178. The first process was visual: she saw the 147 as if printed in black on a white background. The figures were situated at about the place from which the sound came. When the 178 was given, she seized on the 17 and saw it under the 14, but did not visualize the 8 at all. Then the addition began, as with *P.*, in the hundreds column. The 3 "comes" without any conscious process. She says the 3 aloud, and then continues, "4 and 7 are 11." This she both hears and seems to say. Then, "8 and 7 are 15, 25;" and the 3 having been already pronounced, the addition is complete. Evidently the process is visual-verbal at first, and afterwards auditory-verbal and tactual-verbal. In this case *H.* saw the disk after saying "4 and 7 are 11," but she not infrequently, especially towards the close of the experiments, saw the disks while adding; that is, she coördinated the two to a greater extent as she became more practised, so that the distraction became less and less effective. In direct contrast with *P.*, the adding at the end of the experiment seemed to *H.* the most distracting of all, because it came as an interruption and completely drove out the memory image of the first disk. The Table shows that her lowest percentage of correct judgments came in this column. In adding during the whole experiment, *H.* says that the memory image of the first disk goes entirely, but she is usually able to call it up at the end. The second addition in this case is usually slower than the first, because she cannot visualize with her eyes open, and so does not group the numbers very well. It is important to note, also, that the disk always seems clearer to her while speaking, and she frequently gets her best ideas of the disk when announcing results. In nearly every case she manages to catch an instantaneous glimpse of the disk at some time while it is displayed. These glimpses, indeed, seem to be her main reliance when she is adding.

(3) *R.*, in adding, visualizes the numbers as they are given, but, unlike the others, does not see them in connection with each other. In adding 127 and 236, for example,

she saw the numbers on a gray background (situated, probably, in the back of her head), but not in connection. The actual process is thus described in her own words : "I say 200+100=300. I do not make my lips move, but am perhaps conscious of hearing myself say them. Then I say 20 and 30 are 50, without connecting it with the 3 at all. Then, 7 and 6 are 13. Then I hear myself say : That would make 63. Then I take up the 3 and see the whole result." (When questioned on other occasions she was not sure that she saw the result.) The important thing to note in connection with *R.*'s adding, however, is that the thought object, the figures, and the real object, the disk, never interfere with each other. Ordinarily she says that she sees the disks just as clearly and remembers them just as well when adding as when not. And this sight of the disk is continuous, and not merely in the intervals of the addition. She frequently says: "I didn't have a moment free, but I saw the disks well." Indeed, the results would tend to show that the addition acts as a stimulus; and that conclusion is highly probable. There were times, however, when the addition acted as a real distraction. This occurred when some mistake annoyed the subject, or something in connection with the addition amused her. At such times she got only a general impression of the quality of the disk, not the usual clear memory image that she generally had.

Introspection and results agree, therefore, in pointing to the conclusion that addition as a distraction affects different subjects in widely differing ways, and that it is frequently no distraction at all. In some cases it may produce a certain degree of inattention, but it cannot be depended upon to produce equal states of inattention in different subjects, or in the same subject at different times.

SECTION II.—OTHER FORMS OF DISTRACTION.

The work in connection with which the various methods of distraction described in this Section were used consisted in the discrimination of the intensity of two sounds, produced by the falling of ivory balls upon ebony plates. The balls were noiselessly released by an electrical attachment. The distance through which they fell varied from 25 cm. to 80 cm. The experiments were given in series of ten each, with differences of 10 and 15 cm. in the first series, 10 cm. in the second series, and 5 and 10 cm. in the third series.[1]

The forms of distraction used were addition, writing the

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[1] See *loc. cit.*, p. 48.

words of a sentence in reverse order, writing the letters of a word backward, translation of simple sentences into a foreign language and writing the words and letters in a reverse order, and discrimination of odors. The details of each method will be described later. One hundred experiments without distraction, and fifty with each method of distraction, were performed with each of three subjects, *R.*, *Pa.* and *M.*, except in the case of the odors, of which 100 were given to both *R.* and *Pa.* Table II shows the results obtained, the numbers representing percentages of correct judgments.[1]

TABLE II.

Subject.	No Distraction.	Addition.	Writing Words of a Sentence Backward.	Writing Letters of a Sentence Backward.	Translation.	Discrimination of Odors.
R.	65	78	74	72	56	47
Pa.	77	69	69	56	68	60
M.	84	76	69	62	—	58

The distraction by addition was not quite the same as that described in Section I. In that case the numbers were read to the subject, while in these experiments the numbers were selected from logarithmic tables. The subject was directed to add across the page, selecting the figure next to the last in each group-column. In no case was the distraction at all serious, except with *Pa.* at times; and she frequently asserted that the selection of the figures, and not the addition, was what caused her trouble. These results agree, therefore, with those given in the previous Section in discrediting addition as a reliable method of distraction.

In distraction by writing the words of a sentence in reverse order, the sentence was read to the subject just before the first ball was allowed to drop. This distraction proved to be more effective than addition, but was not continuous; the attention was released, in good part, from the process just as soon as the reverse order of the words came into the subject's mind. The mechanical process of writing the word distracted to a very small extent only.

Spelling words backward proved to be fairly effective ex-

[1] The subjects are Miss Parrish (*Pa.*), Miss Root (*R.*) and Mr. Moyer (*M.*),—all highly practised subjects.

cept with *R.*, who did better with it than with no distraction. The distraction was more nearly continuous than in the case of writing words in reverse order, because the mind could not think very far ahead and then leave the rest to the hand. It worked particularly well with *Pa.*, who in eight cases out of fifty was unable to give any judgment at all, the distraction having driven all memory of the first sound from her mind.

The most complicated mental distraction given consisted in translating simple sentences into a foreign language, and writing both words and letters in reverse order. It was found best to let the subject translate into the foreign language with which she was most familiar, because inability to think of any form of expression at all results in poor distraction. *R.* therefore translated into Latin, and *Pa.* into German. Both subjects were uncertain about their judgments, although nearly always, especially in the case of *Pa.*, some attention was given involuntarily to the sounds. *R.*, who has devoted a good deal of time to Latin, was particularly interested in the work, and frequently became so absorbed in it that she did not remember the first sound at all.

The last method tried was the discrimination of odors. For this purpose thirty-three vials were provided, each containing about one dram of some essential oil or other easily procurable odorous substance. These were kept in a box at the side of the subject. At the signal "ready," the subject put the hand into the box, drew out a vial and uncorked it. As it was found that this operation required about four seconds, the signal "ready" was given four seconds in advance of the first sound, so that the sound and the first impression of the odor might be nearly simultaneous. The subject was asked to name the odor if possible, and, if not, to tell what it suggested. In case the name was thought of before the second sound came, the subject was requested to think of as many associations as possible in connection with the odor. This last was done to insure some distraction after the odor had been recognized, for it was found there was not time for the subject to attempt to recognize another odor.

Certain facts were apparent as soon as the work had been well started. Very faint odors, odors so well known as to be recognized immediately, and entirely unknown odors, do not make good distractions. A very faint odor is likely to start no train of thought at all; an odor which is immediately recognized ceases to hold the attention; and one that is entirely unknown fails to attract the attention, and so is practically no distraction. The most complete distraction is produced by those odors which are familiar, but the names of which

elude the subject. In such cases distraction is complete, because all the elements of good distraction—continuity, interest, a strong affective tone (annoyance, usually) and active thought processes—are present. To secure such distraction, odors of the kind described must be provided. It is well to have enough odors to avoid giving the same one twice at one sitting, and the stock must be revised daily for each subject. For this a large number of odors will be required, but any chemical laboratory can supply them. The results given in the Table do not, of course, show the best results possible with this method; the results from good and bad 'distractors' are simply averaged. But it seems possible that a series of odors could be made out for every subject, which should secure all necessary degrees of distraction, from minimal to maximal.

SUMMARY.

The conclusions reached as a result of this investigation may be summarized as follows:

1. Addition as a distraction does not affect all persons or the same person at different times in the same way, and in some cases does not act as a distraction at all.

2. Practically the same thing may be said of writing the words of a sentence in reverse order, and of spelling words backward.[1]

3. Even so complicated a distraction as translating into a foreign language, and then writing both words and sentences in reverse order, does not produce results which show steady inattention. The best results reached with it were caused not so much by the complexity of the process as by the affective tone given to the distraction by the interest of the subject in the operation.

4. The method of distracting by requiring the subject to discriminate odors approaches most nearly of all the forms examined to the production of a state of inattention which is continuous, capable of gradations, and uniform. With care in the selection of the odors given, the method may quite possibly furnish the measure of attention required for experimental work.

[NOTE.—During the present year, 1896-7, a special investigation into the efficacy of odor-series for distraction is in course in the Cornell Laboratory.—E. B. T.]

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[1] Table II shows that *R.* gives better results with distraction than without it, except in translation and discrimination of odors.